GEOLOGY AND DIATREMES OF DESERT MOUNTAIN, UTAH

by

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ABSTRACT

The Desert Mountains and the Allison Knolls make up a group of isolated peaks which rise from part of the Bonneville lake plain. The area is in Juab County and is located about 24 miles west of Jericho and about 35 miles north of Delta.

Sedimentary rocks are exposed in the northeast part of the area. They consist of Precambrian Sheeprock Series and Ordovician Fish Haven Dolomite. The older rock has been thrust on top of the dolomite by what is probably the Sheeprock Thrust.

Most of the bed rock exposed in the area is intrusive. Two distinct intrusive rocks are present. The older is a very dark colored granodiorite. The other is a light colored granite. Aplite, pegmatite and lamprophyre dikes cut the granite.

A diatreme complex is located east of Desert Mountain. The complex is characterized by an igneous matrix which has fragments and large blocks of dolomite, quartzite, slate, jasperoid, and igneous rocks suspended in it.

Extrusive rocks occur mainly in the eastern part of the area. All the volcanics are thought to be equivilents of the Keg Mountain Ignimbrites. Two volcanic units are altered and apparently correlate with the older rocks of the Keg Mountain Ignimbrites.

The structure is dominated by three shear directions, sheeting, and thrust fault mentioned above. The three shear directions form a pattern similar to patterns produced by model work from strike-slip stresses. The pattern is also similar to rock fracture patterns under compression. These similarities together with the general east-west alignment of intrusions and volcanic vents, suggests that there is deep-seated structure control with left-lateral movement.

Hydrothermal alteration occurs in many areas but generally is weak. Locally the alteration is moderately strong. Some small copper deposits occur in the western part of the area but they are too small to be of economic interest.

INTRODUCTION

Location and Geography

Desert Mountain is in Juab County, approximately twenty-four miles west of Jericho by gravel road or thirty-five miles north of Delta by an improved dirt road. It is the highest point (6482 feet) in a cluster of isolated peaks which make up the Desert Mountains and Allison Knolls. The Desert Mountains and Allison Knolls make up the area mapped. The mapped area is located mostly in T. 12 S., R. 6 and 7 W., Salt Lake Base and Meridian. Figure 1 shows the location of the mapped area.

The Jericho-Callao road provides the easiest access to the area mapped. There are many dirt roads and trails which provide ready access to every part of the mapped area. Many of these roads and trails are not suited for passenger car travel.

The Desert Mountains are steep and jagged and rise from a lake plain that slopes gently southwestward. The lake plain and shoreline features that flank the mountains are related to Lake Bonneville.

The climate of the region is arid and there is no surface water in the range. The nearest water is at Judd Creek to the north of Cherry Creek to the east. The sparse vegetation is limited to sagebrush and other similar shrubs with a few junipers in a few places.

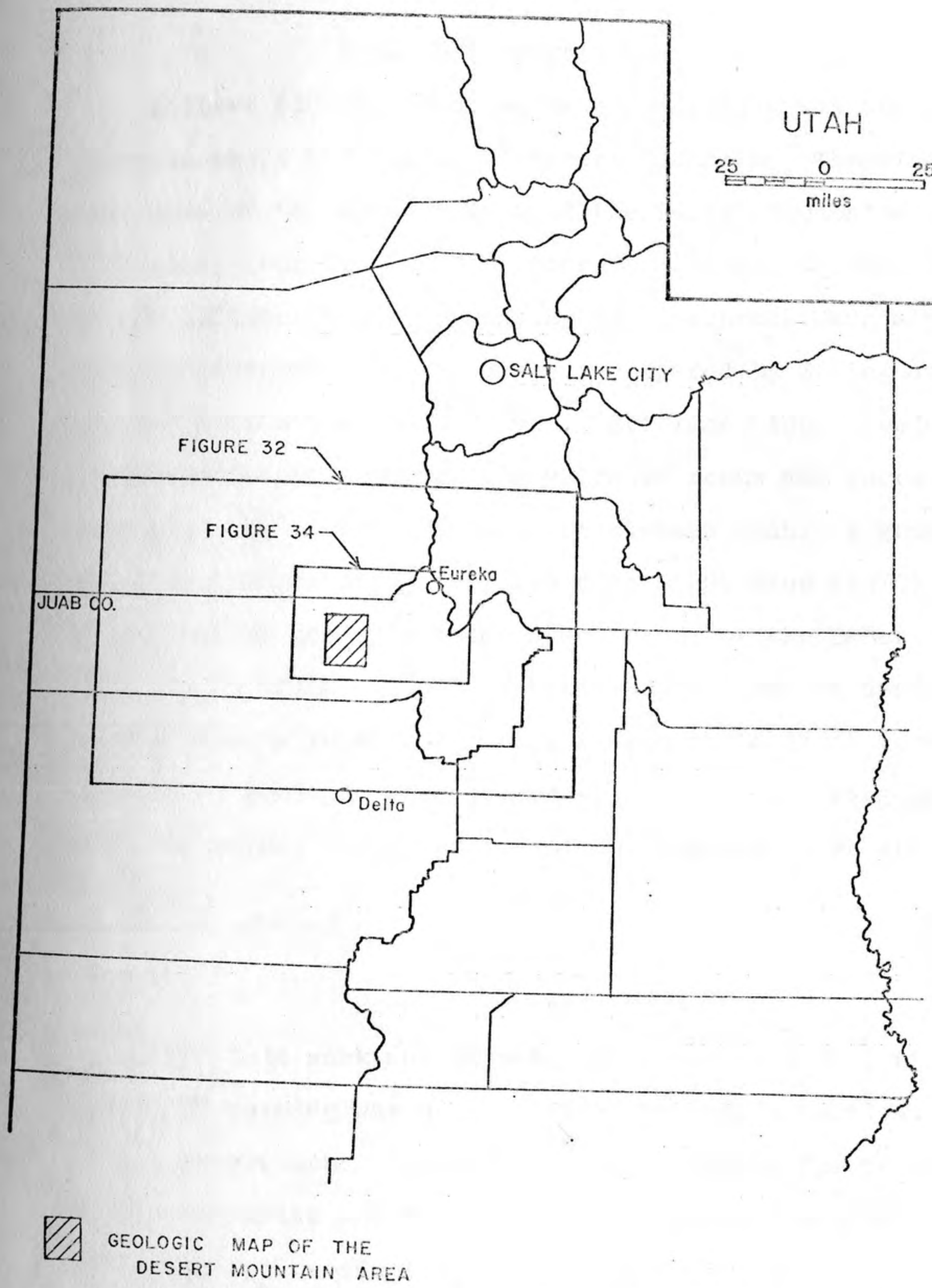


FIGURE 1
LOCATION MAP

Previous Investigation

Gilbert (1890), studying Lake Bonneville was the first to write about the region of Desert Mountain. The mineralized area of the western part of the Desert Mountains was visited by Loughlin (1920). Cohenour (1959) included part of the Allison Knolls in mapping the Sheeprock Mountains. A reconnaissance geologic map was prepared by Stringham (1961) for the Utah state geologic map. Erickson (1963) conducted a reconnaissance study of the volcanic rocks and correlates them with the other volcanics of Western Utah. A ground magnetic and gravity survey was done by Calkins (1970). A more detailed geologic mapping and study of the Desert Mountains by Kattelman (1968) emphasized petrographic aspects of the igneous rocks. For this reason the present work emphasizes geologic aspects not covered or not recognized in previous works. Descriptions of the igneous rocks are from Kattelman.

Present Investigation

The field work was done in the summer and fall of 1970. The field mapping was done on black and white vertical aerial photographs. Specimens were collected for comparison with other areas and for thin section study. Samples were collected for geochemical analysis.

After completing the field mapping, color-stereo aerial photographs of the area became available. The area was mapped again on the stereo plotter with my field map for reference. This process, though backward, gave me better control and a few structures were added to the field map. The only topographic map of the Desert Mountains is the Delta Quadrangle at a scale of 1:250,000 on which exact location is difficult.

About thirty-five thin sections were examined with a petrographic microscope. Photographs were taken of some and are included in this paper.

The samples for geochemical studies were analyzed qualitatively on the emission spectrograph, and quanitatively on the atomic absorption unit for selected elements. The results are detailed in table 1.

GEOMORPHOLOGY

The Desert Mountains are topographically isolated from any other mountains in the area. To the northeast is a bajada sloping up to the Sheeprock Mountains and on the other three sides is an extensive lake plain, a remnant of Lake Bonneville.

The mountains themselves are steep and jagged with a local relief of about 1000 feet. The Allison Knolls are rounded and have lower relief than the Desert Mountains.

There is no evidence of Basin and Range type faulting in the mountains. If present, this type faulting is concealed. Fault scarps occur in the volcanics in the southern part of the mountains.

Terraces and bars formed in former Lake Bonneville are common in many parts of the mountains and in the flats. Two bay-mouth bars occur in the northwestern part of the mountains (Fig. 2). To the west was a large river which drained the "Sevier body" of Lake Bonneville into the main body as the lake receded (Gilbert 1890, p. 183).

STRATIGRAPHY

General Statement

Sedimentary rock makes up a very small part of the outcrops in the Desert Mountains. Sedimentary rock inclusions are associated with diatremes in the eastern part of the Desert Mountains. Sedimentary rocks are exposed in both plates of a major thrust fault which is exposed in the Allison Knolls.

Precambrian System

Sheeprock Series (Undifferentiated)

Exposures of interbedded quartzite and argillite occur in the northern part of the Allison Knolls with a few outcrops to the south of the Jericho road. The exposures are rounded hills with few outcrops. The color of weathered outcrop is dark reddish-brown but the fresh surface is generally lighter colored. Some of the argillites are black but most are tan and light gray. In the northern section there are some outcrops of tillite which contain mainly small rock fragments. Cohenour (1959, pl. I) called the rock of Allison Knolls Dutch Peak tillite and Kattelman (1968, p. 88) designated it as Lower Sheeprock Series. I have mapped the rock as undifferentiated Precambrian Sheeprock Series.

Argillite and quartzite are abundant as inclusions associated with the diatremes to the east of Desert Mountain, therefore they are assumed to underlie that area. In the vicinity of the thrust, the rock is brecciated and silicified (Fig. 12).

Ordovician System

Fish Haven Dolomite

A few small outcrops of dolomite occur in the northern part of the Allison Knolls. One outcrop occurs south of the Jericho-Callao road and a few blocks are found in the southern part of the diatreme area. Cohenour (1959, p. 78) identified the outcrops as Fish Haven Dolomite from fossil evidence. The dolomite is dark to medium gray with some reddish-tan weathered chert nodules. The outcrops are of low relief and the exposed rocks are brecciated. The undifferentiated Sheeprock Series have been thrust on top of the Fish Haven Dolomite in the area mapped.

Quaternary System

Lake Bonneville Sediments

There are many Lake Bonneville terraces, beaches, bars and spits in the Desert Mountain area. The plain that surrounds the mountains is a lake plain with beaches and other Lake Bonneville features very evident. Lake Bonneville deposits are shown undifferenciated on the map except for some gravel cemented by calcareous material. Cemented gravel occurs in other areas also but only in the bars and spits are the outcrops large enough to be shown on the map (Fig. 2). There are two distinct bay-mouth bars in Sec. 16 of T. 12 S., R, 7 W..

Alluvium

As noted above there are large areas of lacustrine sediments in and around the Desert Mountains. These sediments are generally unconsolidated. Post Lake Bonneville alluvial sediments are present also.

IGNEOUS ROCKS

General Statement

Most of the Desert Mountains are composed of intrusive igneous rock. Extrusive igneous rocks are exposed on the east side of the mountains and in the Allison Knolls.

Kattelman (1968, p. 90) believes the Desert Mountain intrusives to be differentiates of the same parent magma becoming generally more acid following the normal order of crystallization. In the West Tintic Mining District, Stringham (1942, p. 287), found that the order of igneous rocks also appeared to follow Bowen's theory of fractional crystallization, with later intrusions more acid. The West Tintic Stock is the closest granitic outcrop to the Desert Mountain intrusions.

The igneous rock types present are mainly granodiorite, granite, and rhyolitic volcanic rock. There are also dikes. These igneous rocks are described below in approximate order of crystallization and by probable origin. Generally the igneous rocks contain some free quartz, which suggest a high silica magmatic source. The presence of silicified rocks further supports a high silica magmatic source.

Intrusive Rocks

Granodiorite

Granodiorite is the oldest igneous rock exposed in the Desert Mountains. The granodiorite crops out generally in a northwest trending zone across the central part of the area. Outcrops are discontinuous in the zone and some granodiorite occurs outside the zone. The younger granite, which occurs in the mapped area, can be seen under the granodiorite and in other areas the contact appears to be vertical (See Fig. 27

and Fig. 3).

Granodiorite outcrops range from steep, jagged peaks to low rolling hills. Large outcrops are not abundant but small outcrops occur in most areas. The granodiorite is dark colored and it was possible to use this characteristic in mapping this unit.

The granodiorite typically has a fine grained dark groundmass with light colored phenocrysts. The minerals that can be determined megascopically are biotite, quartz, and plagioclase. Epidote is common along fractures throughout the outcrop area. Locally the granodiorite grades into a quartz monzonite phase.

Most of the microscopic information given is from Kattelman (1968, p. 90). The phenocrysts range in size from .1 mm. to 3.0 mm. and the rock is a microporphyry. The rock has a granular texture with few euhedral grains. The plagioclase has an average composition of $Ab_{56}An_{44}$ and has normal zoning. Both quartz and potassium feldspar exhibit some resorption. The ground mass is too fine grained to be identified for the most part.

Epidote, sericite, albite, and calcite are observable microscopically. These alteration minerals indicate a weak propylitic alteration assemblage.

The following gives Kattelman's (1968, p. 91) average composition of the granodiorite (10 samples).

K-feldspar	11.4%
Plagioclase	47.9%
Quartz	11.8%
Biotite	21.4%
Hornblende	1.4%
Magnetite	6.1%
Zircon	(rare)
Apatite	(rare)

Kattelman (1968, p. 91) noted that biotite, magnetite and the percentage of anorthite in the plagioclase, generally increases to the northwest.

Odekirk made (1963, p. 26) age determinations of two rocks in the Desert Mountains using the Lead-alpha method on zircon crystals, common in the intrusive rocks. A "hornblende-biotite granite," here assumed to be the granodiorite, had an indicated age of 41 million years which is late Eocene.

Granite

The light colored granite is the most abundant rock type in the Desert Mountain area. The light color of the granite makes a bold contrast with the very dark granodiorite. The outcrop areas are not continuous, but are isolated by broad valleys and exposures of other rock types. The granite outcrops are generally bold, forming cliffs and jagged, high relief mountains. Most outcrops are large which facilitates structural studies.

The granite is thought to be younger than the granodiorite because of the contact relations as well as age determinations by Odekirk (1963, p. 26). An age of 36 million years (Oligocene) was indicated using the Lead-alpha method on zircon. The contact in Sec. 36 T. 12 S., R. 7 W. is very sharp as shown in Figures 26 and 27. The granite in this section is very fine grained at the contact but is locally pegmatitic a few feet back from the contact. This relationship suggests rapid cooling at the contact which released the volatiles which in turn led to the formation of the pegmatitic pods. In several other areas the granite appears to be under the granodiorite suggesting that the granite was intruded into the pre-existing granodiorite.

The granite is weathered into rounded, crumbly outcrops which often allows the forming of windblown holes. There is an arch in the granite in Sec. 15, T. 12 S., R. 7 W.. The texture generally appears equigranular but a closer look reveals a generally porphyritic texture with phenocrysts ranging up to 15 mm.. The granite is "white" in the southwestern part of the outcrop area but is "pink" in the eastern outcrops. The color is in the feldspars and the color change appears to be gradational. There is a possibility that the granite represents more than one intrusion but if so, the contacts are buried under alluvium. However, the gradational nature of the change in the color of the feldspars suggest a single intrusion. The granite locally grades into a quartz monzonite phase.

The following petrographic description is based on data from Kattelman (1968, p. 95), and on observations of thin sections prepared for the present report. The porphyritic portions of the granite have phenocrysts ranging in size from 3 mm. to 15 mm.. The phenocrysts make up to 40% of the rock. The ground mass grains are approximately 1 mm. in size.

The feldspars are generally euhedral. Microperthite is common with the albite occuring as thin stringers. The andesine has an average composition of $Ab_{68}An_{32}$. Resorption is evident in both feldspar and quartz. Undulatory extinction in quartz is commonly observed. The average composition for the granite based on (18 samples) is as follows:

K-feldspar	57.8%
Plagioclase	12.6%
Quartz	24.9%
Biotite	4.0%
Magnetite	0.7%
Zircon	(trace)
Sphene	(trace)

Kattelman called the intrusive rock leucogranite porphyry.

Dikes

Aplite Dikes - Aplite dikes occur mostly in the granite and are most common in the southern and western sections. Aplite dikes cross the contact and continue into the granodiorite in Sec. 36, T. 12 S., R. 7 W.. The dikes generally are less than two feet in thickness and less than

100 feet in length and follow the shear directions.

The rock is white and has a sugary texture. The grain size is generally less than 1 mm. and has a rather uniform size range (See Fig. 18). Locally the aplite is very quartz rich. Kattelman (1968, p. 100) gave the following composition (8 samples):

K-feldspar	62.1%
Quartz	27.2%
Plagioclase	9.4%
Biotite	0.6%
Muscovite	0.4%
Magnetite	0.3%

There is some microperthite present and the plagioclase is $Ab_{96}An_4$ (Kattelman 1968, p. 99).

Pegmatite Dikes - Associated with and sometimes grading into the aplite dikes are pegmatite dikes. The pegmatite dikes are usually small and are not shown on the map. They are composed mostly of quartz and K-feldspar with some local muscovite.

Aphanitic (Lamprophyre) Dikes - There are many aphanitic dikes in the Desert Mountains. Most occur in the western and southern parts of the granite. The fine-grained, dark colored dikes usually follow the joints and dip northerly about 60° to 70°. The dikes range in size up to 25 feet wide and the length ranges from a few feet to over a mile (see Figs. 4, 9 and 10). In hand specimen they are dark green. The green color is darker in some areas than in others.

The dike rock is dense, compact, and resistant to weathering.

Kattelman (1968, p. 101) classified the dikes as lamprophyres. He identified three rock types: odinite, odinite porphyry, and kersantite with the following mineral assembleges.

Odinite and Odinite porphyry

Plagioclase	61.7%
Biotite	3.5%
Hornblende	28.7%
Magnetite	6.1%
Pyrite	(trace)

Kersantite

Plagioclase	78%
Biotite	12%
Hornblende	5%
Magnetite	5%

The odinite, the most common, is slightly porphyritic, and has an average grain size of 0.3 mm., with hornblende crystals as long as 3 mm.. In the odinite porphyry the phenocrysts range in size up to 10 mm.. The plagioclase is labradorite and is $Ab_{45}An_{55}$ (Kattelman 1968, p. 101).

The kersantite occurs only in a few places and is a light green color (Kattelman 1968, p. 102).

Diatreme (?) Complex

East of Desert Mountain is an area of complex geology. When viewed from a distance the area is dominated by somewhat isolated, bold outcrops. These outcrops differ in color and lithology and are precambrian quartzite and argillites, Ordovician Fish Haven Dolomite, and igneous rocks of differing types. They occur as jumbled blocks and in many cases a matrix of igneous rock can be seen surrounding the blocks. Many blocks are quartzite and slate with most slate blocks being black. Many blocks of sedimentary rock in the complex are intensly silicified and brecciated and have a similar appearance to the rocks near the exposed thrust fault to the north. The igneous inclusions are also of varying sizes but not as large as the sedimentary blocks. The top of one mountain appears to be a large sedimentary inclusion. The igneous inclusions vary in composition and color but most have free quartz.

The Desert Mountain complex is about 11,000 feet long and as much as 4,500 feet wide in its outcrop area. The complex is tadpole shaped with the large end to the north.

Fig. 2 Lake Bonneville spit (left) and bay mouth bars. Gravel cemented with calcareous cement (Sec. 16, T. 12 S., R. 7 W.).

Fig. 3 Dark granodiorite intruded by light colored granite. Desert Mountain (Sec. 13 and 14, T. 12 S., R. 7 W.).

Fig. 4 Dike in granite (Sec. 16, T. 12 S., R. 7 W.).

Fig. 5 Northeast shear in granite (Sec. 21, T. 12 S., R. 7 W.).

Fig. 6 Probable cinder cones. The centers of both are silicified (Sec. 4 and 5, T. 12 S., R. 6 W.).

Figure 2

Figure 3

Figure 4

Figure 5

Figure 6

Fig. 7 Sheeting (right) and shearing (left) in granite. (Sec. 21, T. 12 S., R. 7 W.).

Fig. 8 Small gravity side block of granite (arrow). (Sec. 17, T. 12 S., R. 7 W.).

Figs. 9 and 10 Dark aphanitic (lamprophye) dikes in granite. Dike in Fig. 9 is about 18 inches wide. (Sec. 28, T. 12 S., R. 7 W.).

Figure 7

Figure 8

Figure 9

Figure 10

Fig. 11 Sheeting in granite near the Rockwell Shaft (Sec. 28, T. 12 S., R. 7 W.).

Fig. 12 Quartzite breccia in the Sheeprock (?) Thrust Plain (Sec. 33, T. 11 S., R. 6 W.).

Fig. 13 Rockwell Shaft looking west (Sec. 28, T. 12 S., R. 7 W.).

Figure 11

Figure 12

Figure 13

Fig. 14 Thin section of granite.

Fig. 15 Thin section of granodiorite.

Fig. 16 Thin section of unaltered rhyolitic volcanic rock.

Fig. 17 Thin section showing possible bedding structure in Precambrian quartzite-argillite.

Fig. 18 Thin section of aplite dike.

Fig. 19 Thin section of Precambrian tillite.

Scale for all thin section photographs

1 mm.

Figure 14

Figure 15

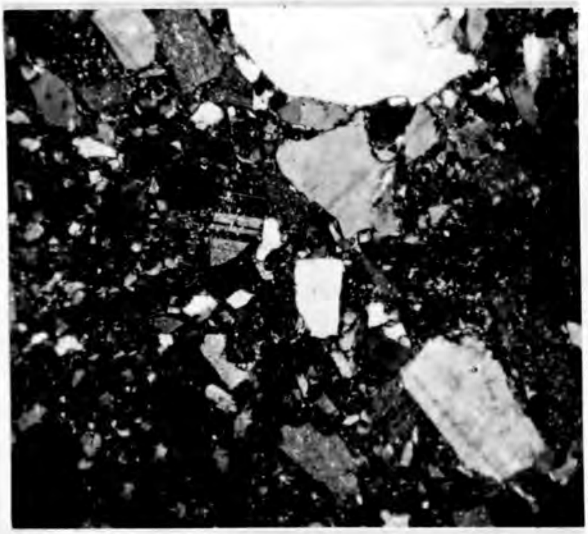


Figure 16

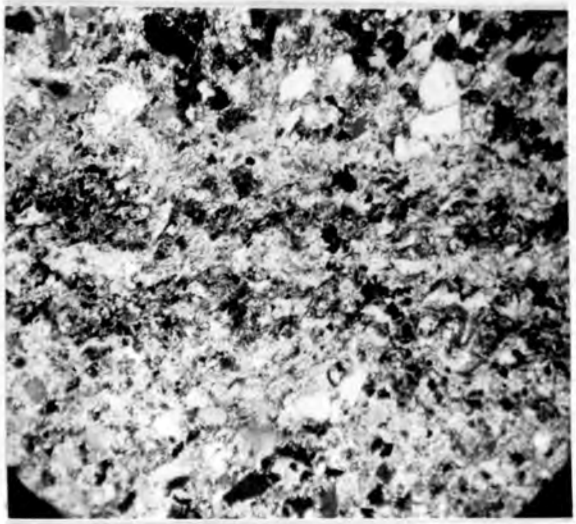


Figure 17

Figure 18

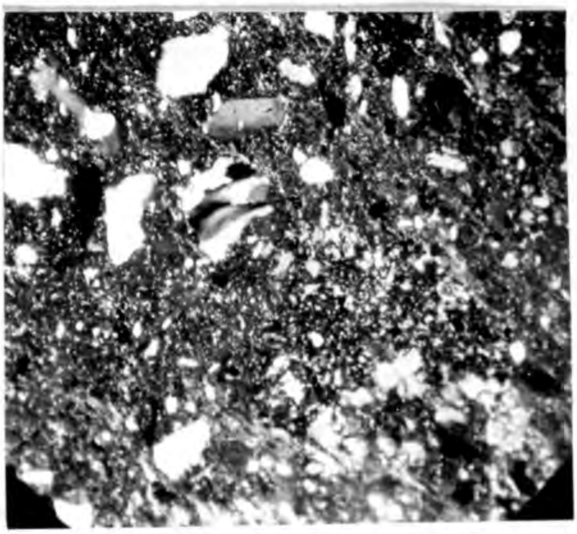


Figure 19

Fig. 20 Thin section of a rock fragment in the diatreme matrix.

Fig. 21 Thin section of small rock fragments and calcareous material in the diatreme matrix.

Fig. 22 Thin section of a quartz vein crossed by a "limonite" vein in altered volcanic rock.

Fig. 23 Thin section of a resorbed quartz grain in altered volcanic rock.

Fig. 24 Thin section of volcanic rock almost completely silicified.

Fig. 25 Thin section of jasperoid. Figs. 22, 23, 24, and 25 show progressively more intense silicification of the altered acid volcanic rock.

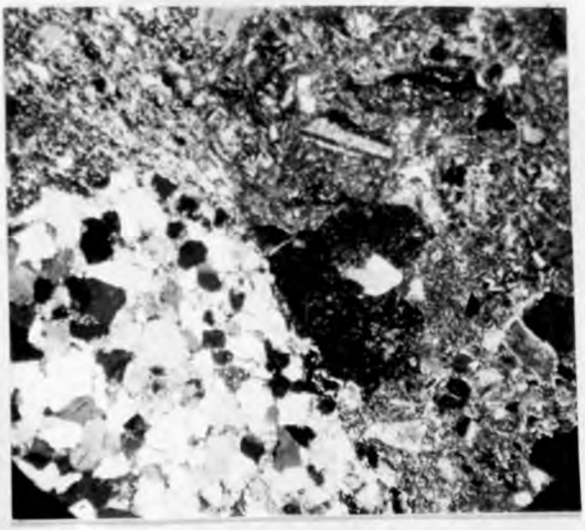


Figure 20

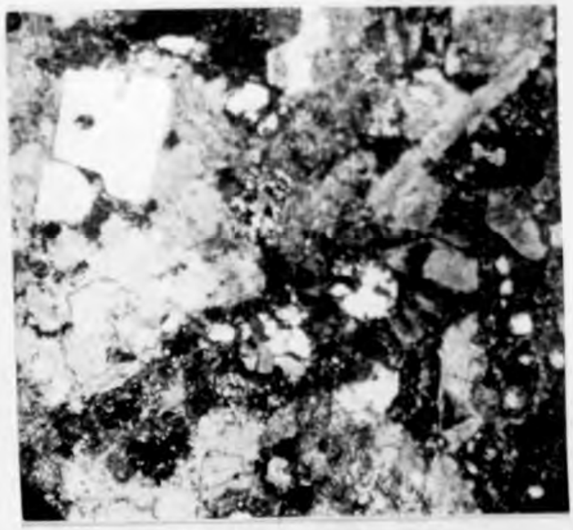


Figure 21

Figure 22

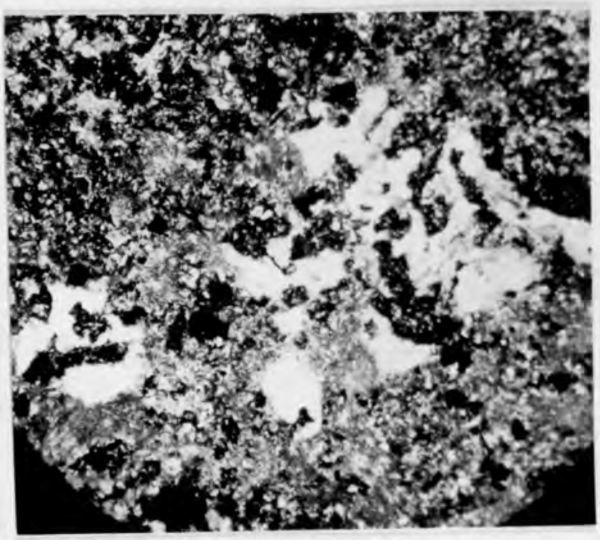
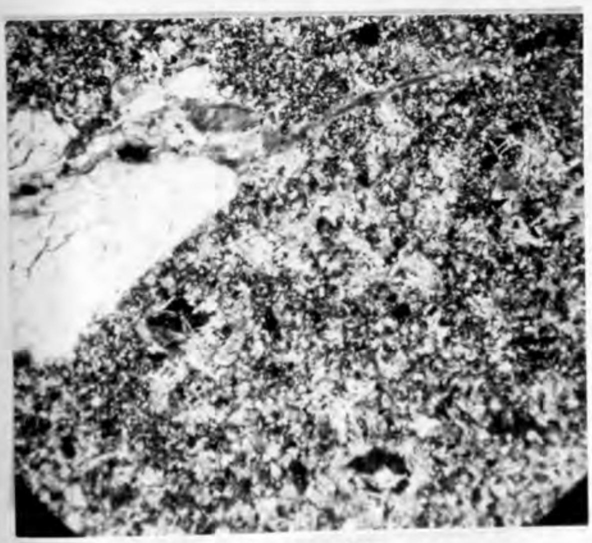


Figure 23



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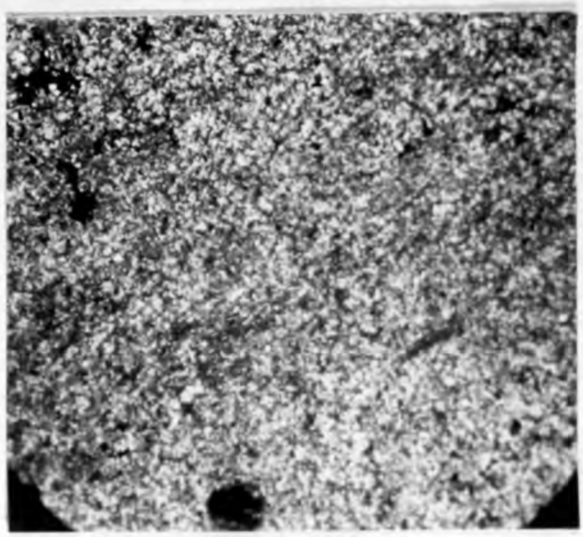

Figure 25

Fig. 26 Thin section of the contact of the fine grained granite with granodiorite.

Fig. 27 Aerial photograph of the same contact as Fig. 26. The contact is very sharp at any scale.

Fig. 28 Thin section of a calcite vein in granite.

Fig. 29 Thin section of quartz-sericite alteration in the sanded volcanic rock.

Fig. 30 Thin section of the contact of the dark aphanitic dike (lamprophyre) with granite.

Fig. 31 Thin section of altered granite. Euhedral "quartz eye" in fine alteration and remnant grains.

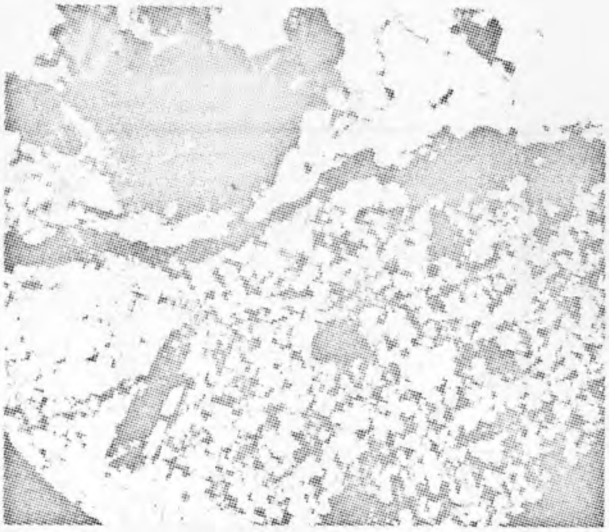

Figure 26

Figure 27

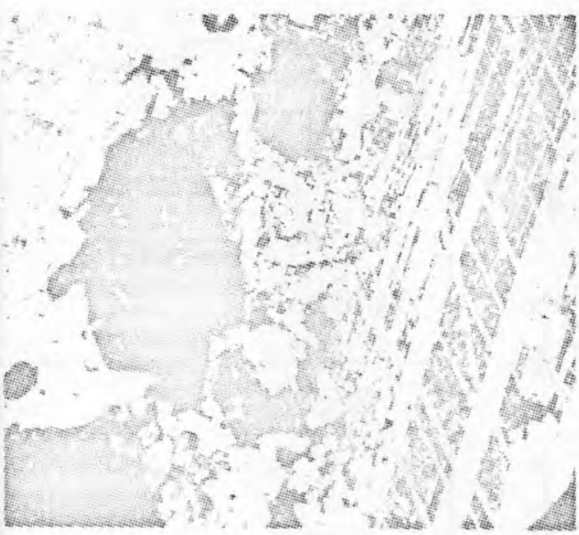

Figure 28

Figure 29

Figure 30

Figure 31

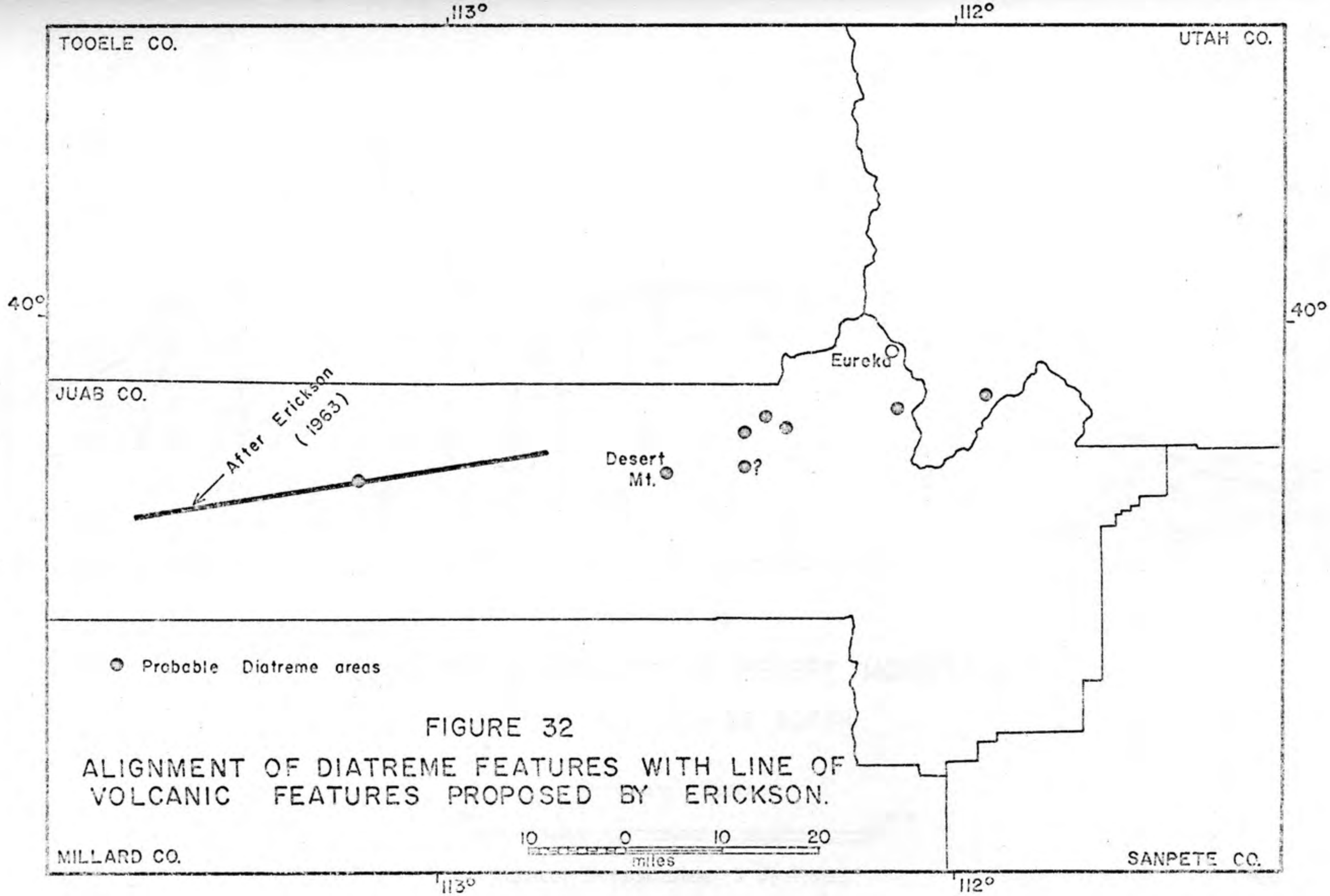

FIGURE 32

ALIGNMENT OF DIATREME FEATURES WITH LINE OF VOLCANIC FEATURES PROPOSED BY ERICKSON.

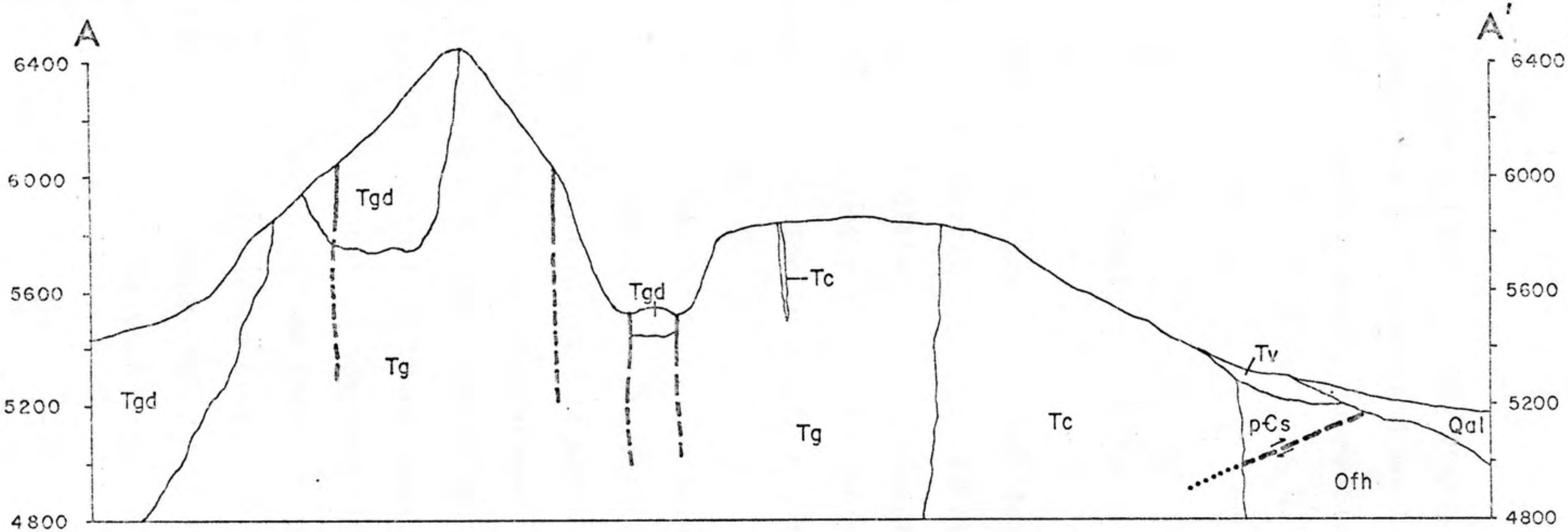

FIGURE 33

GEOLOGIC CROSS-SECTION DESERT MOUNTAIN

SECTION A-A' LOOKING NORTH

Horizontal Scale

0 1 mile

Vertical Exaggeration 3 1/2 Times

Kattelman (1968, p. 88) described the area by stating, "The quartzite inclusions and roof pendants occur in a northwest trending belt...surrounded by the rhyolite porphyry which includes them. The inclusions range in size from one millemeter to several acres. As they are more resistant to weathering than the including rhyolite, the quartzites cap ragged peaks that protect the steep rhyolite slopes."

Similar features have been described in the West Tintic Mountains by Morris and Kopf (1967) as breccia pipes or diatremes. A diatreme is a volcanic vent or pipe which has cut the pre-existing rock with the explosive energy of a gas charged magma. The Desert Mountain complex is thought to be a diatreme.

The West Tintic diatremes have a stratigraphic displacement, of included rock fragments, of as much as several thousand feet upward (Morris and Kopf 1967, p. C68). By comparison the upward displacement in the Desert Mountain diatremes is about 600 feet or less. The determination of the upward movement is based largely on the inferred location of the thrust fault in the area. There are relatively few blocks of dolomite from the lower plate of the thrust exposed in the diatreme complex. There are many brecciated and silicified blocks, as noted above, from the thrust plane. The diatremes in the West Tintic Mountains show a rude compositional zonation, especially so in the Maple Peak breccia pipè (Morris and Kopf 1967, p. C69). In the Desert Mountain breccia area zonation is not apparent, although detailed work might reveal faint zoning.

The contacts of the West Tintic pipes are well defined. The apparent age is post Eocene. In the Desert Mountain area the diatreme contact with the granite is distinct and it appears the diatreme intruded the granite. The contact with the volcanics is indistinct and it appears that the volcanics are resting on the diatreme. This idea is further supported by the fact that the older volcanics are often exposed nearest the mapped diatreme outcrop. The volcanics are probably Miocene in age and the granite is early Oligocene so the diatreme is apparently Oligocene or Miocene in age.

In the northern part of the diatreme complex, the matrix rock is green with white or pink phenocrysts. Many broken grains are seen in the microscope. Rock fragments are included in the matrix.

The composition of the rock cannot be accurately determined because of the fine grained nature of the matrix, weak alteration, and many inclusions present. However, there is enough plagioclase visable to suggest that the rock is latitic in composition. Little quartz can be seen in thin section or hand specimen. Some resorbtion was observed.

In the southern part of the diatreme complex the matrix rock is different in appearance and composition. The rock is still green colored but lighter. Quartz is commonly visable in the hand specimen and no plagioclase is seen in thin section. The rock is a rhyolite porphyry. Inclusions of quartzite, slate, jasperoid and igneous rocks range from microscopic to tens of feet in diameter but the larger inclusions are in the northern part of the diatreme complex. Dolomite fragments are present in the southern part but are seldom seen in the northern part of the complex.

Several large blocks of the northern type matrix rock were observed in the southern part of the complex. This suggests that the southern area was active at the same time as the northern area but was reactivated later, with a more acid rock being emplaced.

The diatremes were probably formed by a gas rich, partially crystallized magma intruding a structurally weak zone. Volcanic material was probably thrown out with the release of gas pressure and in the process blocks and fragments of other existing rock were broken loose and moved upwards. Once the pressure was released the magma solidified.

The diatremes of the Desert Mountain area occur in a narrow, nearly straight zone in which several volcanic centers are located. The zone described by Erickson (1963) extends from Honeycomb Cliffs in the west and projects to Sunrise Peak in the East Tintic Mountains. A distance of over 80 miles. Erickson suggested a deep-seated structure along this line or zone which allowed access of magma at depth and outbreaks of lava at the surface. Volcanic centers included the Honeycomb Cliffs Rhyolite, the Spor Mountain diatremes, the Thomas Range Volcanic center, two volcanic centers in the Keg Mountains, and Sunrise Peak center of volcanic activity in the East Tintic Mountains. Since that time Morris and Kopf (1967, p. 68) have recognized and described three diatremes in the West Tintic Mountains and one in Copperopolis Canyon (Morris, personal communication in the field) of the East Tintic Mountains. Muessig (1951) described a feature whose origin he compared to the pebble dikes of the Tintic distirct. It is in the northern part of Long Ridge. The Long Ridge diatreme extends the zone beyond the East Tintic Mountains. Figure 32 shows the trend and alignment of these diatremes and volcanic centers.

This deep seated structural zone trends in the direction of the transform faults associated with ocean floor spreading centers. Since the spreading centers at this latitude appear to have been over-ridden by the continental plate, an attempt was made to correlate observed structures in the Desert Mountain region with plate tectonic concepts

(See Regional Structure).

Extrusive Rocks

Altered, Acid Volcanic Rocks

Altered, acid volcanic rocks occur in large areas along the eastern part of the Desert Mountains and into the Allison Knolls. The alteration is generally argillic alteration, silicification, and bleaching, the latter being the most conspicuous. Locally silicification is so intense that it completely obliterates the original texture (See Figs. 22, 23, 24, and 25). These areas are marked as jasperoid on the map. Pyritic alteration is locally common and usually controlled by shears.

The altered volcanic rocks occur as low rolling hills with few outcrops and are locally bleached and iron stained giving them a blotchy appearance. The rock appears to have had free quartz before it was altered and more quartz has been added with the alteration. Small fragments of igneous rock are present in the rock suggesting a clastic origin.

North of the Jericho-Callao road are two hills, one of which is very symmetrical, the other is more elongated. These two hills are thought to be cinder cones because of their shape, with their throats intensly silicified. There is a strong possibility that these hills are younger than the volcanics discussed here but because of the similarity of rock types they are mapped as older volcanic rocks.

Resorbed and broken grains can be seen under the microscope, as well as quartz filling fractures (See Figs. 22 and 23). Feldspars can be seen in some sections and in others only outlines are observed.

Sanded-altered Volcanic Rocks

In the central part of the map area is a fine-grained, sandy looking, volcanic rock. This rock is similar to the altered, acid volcanic rock in all aspects except texture. It is on the basis of texture that they are separated. This rock is locally, intensely altered by quartz-sericite alteration (Fig. 29).

Rhyolitic Volcanic Rocks (Unaltered)

Along the eastern side of the Desert Mountains and Allison Knolls are unaltered volcanic rocks that are probably similar to the altered rock discussed above but younger. These rhyolitic rocks form both rugged peaks and ridges with bold outcrops and low rolling hills with few outcrops.

The rock contains many inclusions, usually igneous, some of which are over ten feet in diameter. The color is varied but usually gray with some pink and green present. The rock usually looks porphyritic with free quartz common. Alteration is rare.

The three volcanic units present in the Desert Mountains probably correlate to the Keg Mountain ignimbrites (Erickson 1963, p. 24). The older volcanics of the Thomas Range have been dated at 19 million years (Staatz and Carr 1964, p. 116) and are probably equivalent to the Keg Mountain ignimbrites (Erickson 1963, p. 24 and map).

The rocks "contain a high percentage of broken crystals of quartz and sanidine, and are so highly welded as to resemble rhyolite porphyries with numerous phenocrysts rather than welded tuff" (Erickson 1963, p. 24). Kattelman (1968, p. 97) did call the rock rhyolite prophyry and noted the broken and resorbed grains. He analyzed the composition as follows: (9 samples)

K-feldspar	53.8%
Plagioclase	7.7%
Quartz	33.1%
Biotite	3.3%
Magnetite	2.1%
Zircon	(rare)

Locally the volcanic rocks are of quartz latite composition (Kattelman 1968).

GEOLOGIC STRUCTURE

General Statement

Shears, joints, faults, and sheeting are found within the igneous rocks. The shears or joints have been mapped as such unless they were very large, continuous, had gouge, had topographic expression, or were silicified, then they were mapped as faults. This philosophy was necessary because of the lack of marker units in the igneous rocks.

A thrust fault of major displacement occurs along the northern part of the Allison Knolls and is possibly the southern continuation of the Sheeprock thrust.

Sheeting

Sheeting occurs in all the intrusive rock in the Desert Mountains. The sheeting has a general strike of N. 30° W. and dips about 45° W., but varies. The sheeting is more pronounced in the western part of the map area becoming weaker to the east. The sheeting has had some control of mineralization.

Shears, Joints, and Faults

In the map area there appears to be three dominant shear, joint, or fault directions. The direction of strongest shearing is about N. 40° - 50° E. dipping steeply to the north. One of these "joints" offsets the vein in the Rockwell Shaft, so some of these shears have had some movement. Not as well developed is a shear having a direction of about north-south to N. 10° W. and dipping steeply to the west. This set of shears and faults seems to be the major control of the mineralization in the map area. The third shear direction is not as well developed and strikes about N. 80° E. with faults being more common than shears or joints.

Thrust Faulting

Small Local Gravity Slide

In the southeast quarter of Sec. 17 T. 12 S., R. 7 W. is what is thought to be a gravity slide block in the granitic rock (See Fig. 8). The block is detached from the main mass on a near horizontal plane. It probably moved when the mountains to the east were higher.

Sheeprock (?) Thrust

A thrust fault of major proportions is exposed in the northern part of the Allison Knolls. It is assumed to be part of the Sheeprock Thrust. Rock of the Precambrian Sheeprock Series is thrust on top of the Ordovician Fish Haven Dolomite. The stratigraphic displacement could be in the order of 17,000 feet. The location of the thrust is implied to the south of the Jericho-Callao road.

The thrust zone is brecciated in both the dolomite and quartzite. Silicification in the upper plate is locally so intense that the brecciation is nearly obliterated. The small exposures of Precambrian rock south of the Jericho-

Callao road are brecciated and silicified, suggesting that the fault plane is near. The approximate trace of the thrust can be located south of the Jericho-Callao road because of the locations of the Precambrian rock exposures and a small outcrop of Fish Haven Dolomite.

REGIONAL STRUCTURE

The Desert Mountain region, as noted earlier, is on a major structural zone. The apparent direction of the zone is N. 82° E. (Erickson 1963, p. 34) and is approximately parallel to the transform faults associated with ocean floor spreading. This deep seated structural zone has controlled not only the location of the volcanic features, but also the intrusive rocks of Desert Mountain and the region (Figs. 32 and 34). The east-west alignment of intrusions was noted earlier by Morris (1967, p. C 68).

Many major east-west structural zones were noted in the western United States before the concepts of global tectonics had been advanced (example Nolan 1943). Shawe (1965) related many earthquakes to deep seated strike-slip movement and now global tectonic concepts offer an explanation for both east-west structural zones and strike-slip movement. These east-west structural features were related to ocean floor spreading by King (1966, p. 2) who noted abrupt changes in the western cordillera along transverse zones which are the

Fig. 34 Map showing relationships of intrusions and diatremes to the extension of the line of volcanic features proposed by Erickson (1963) into the Tintic-Desert Mountain area.

intrusions

diatremes

Adopted from Thomas (1958), Cohenour (1959), Groff (1959), Morris and Kopf (1967), and Morris and Lovering (1961).

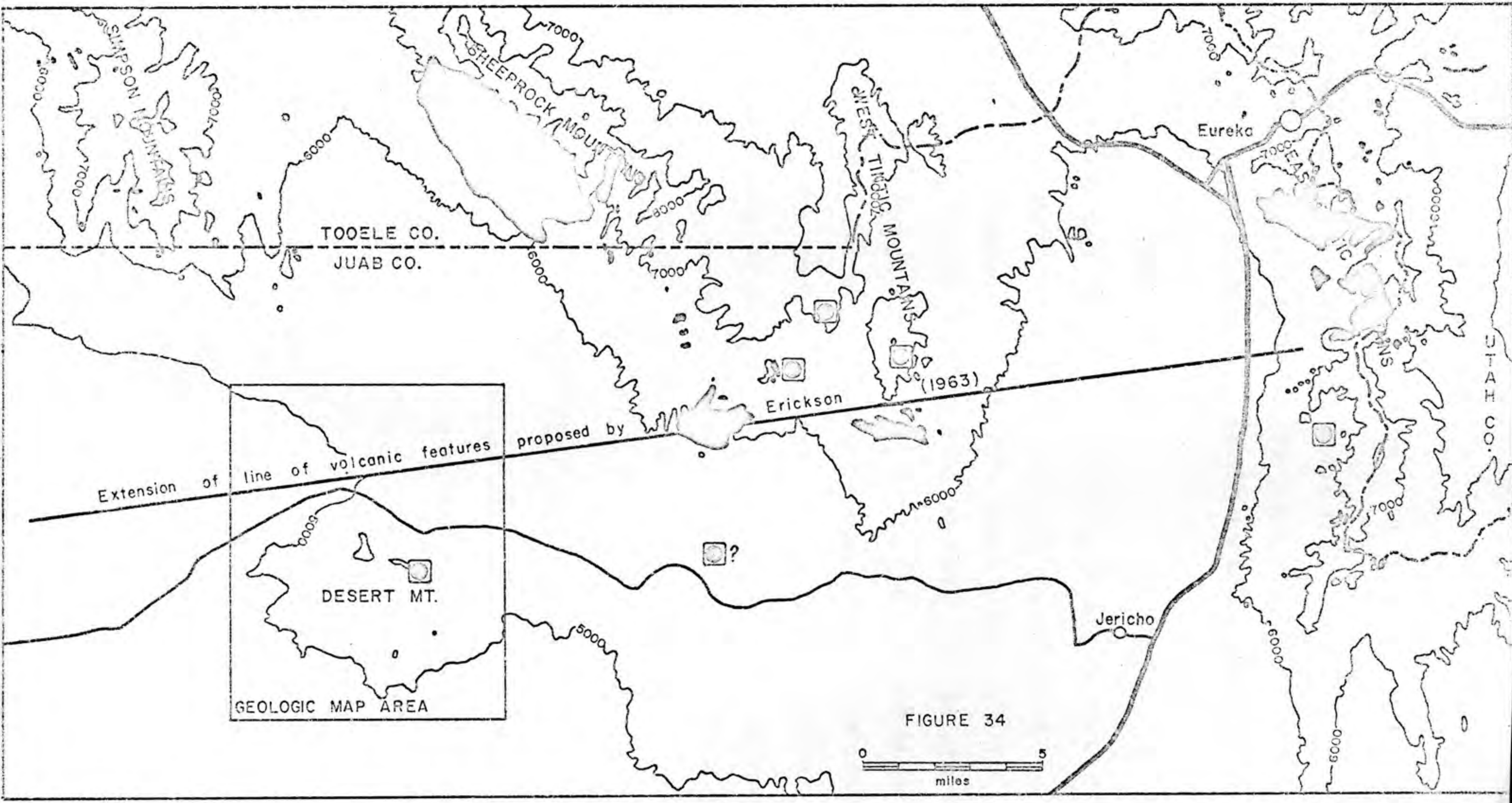
SIMPSON MOUNTAINS
SHEEPROCK MOUNTAINS
WEST TINTIC MOUNTAINS
TOOELE CO.
JUAB CO.
UTAH CO.
Eureka
Jericho
DESERT MT.
GEOLOGIC MAP AREA
Extension of line of volcanic features proposed by Erickson (1963)
7000
6000
5000
0
5
miles

FIGURE 34

landward extensions of the transform faults off the west coast of the United States. The east-west structural zones are not all related directly to transform faults in the ocean floor.

Model work has been useful in duplicating structural features observed in nature. Figures 35 and 36 show the theoretical structure patterns produced by horizontal strike-slip movement derived from model work. The pattern which occurs in the Desert Mountains (Fig. 38) is similar, but has an even greater similarity to the work of Borg and Handin (1965) who put "basement" rocks under compression (Fig. 37). The implication is that the major regional structural zone of western Utah has had left-lateral movement which has caused the structural pattern observed in the Desert Mountains.

HYDROTHERMAL ALTERATION

General Statement

Many of the rocks in the Desert Mountains are fresh except for surface weathering. However, there are many areas where weak hydrothermal alteration is observable and strong alteration is present in a few areas.

Fig. 35 Diagram of the Riedel experiment. (R) Riedel shear. (R') Conjugate Riedel shears. Shows fracture pattern with shear. (Modified after Tchalenko, 1970, p. 1626).

Fig. 36 Diagram showing the theoretical angle produced by shearing. (P) Thrust shear. (R) Riedel shear. (R') Conjugate Riedel shear. (a) Peak angle of shearing. (Modified after Tchalenko, 1968, p. 161).

Fig. 37 Diagram showing the general fracture pattern developed in rock put under compression. The pattern varies with different rock types.
(a) main fracture or fault (angle about 60°).
(b) conjugate fractures or faults (angle from 56° to 98°). (c) extension fractures or faults.
(d) release fractures or faults. (Modified after Borg and Handin, 1965, p. 269).

Fig. 38 Diagramatic representation of the structural pattern of Desert Mountain with a symbol at the bottom to show the postulated movement. Compare with Fig. 36.

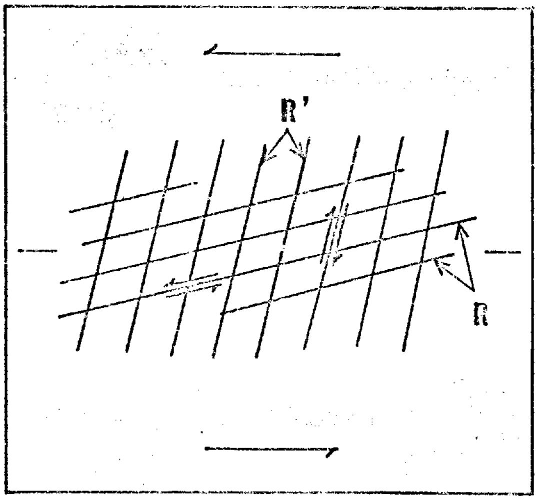

FIG. 35

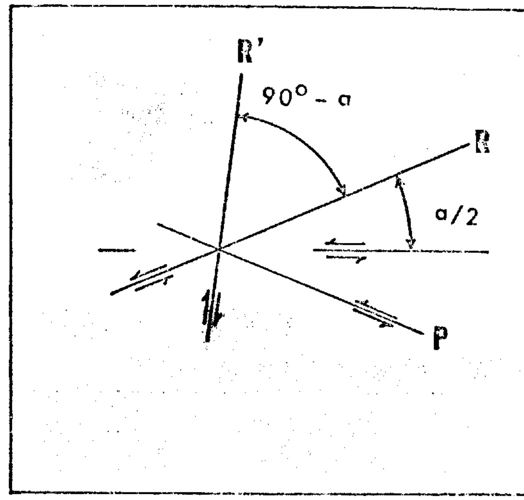

FIG. 36

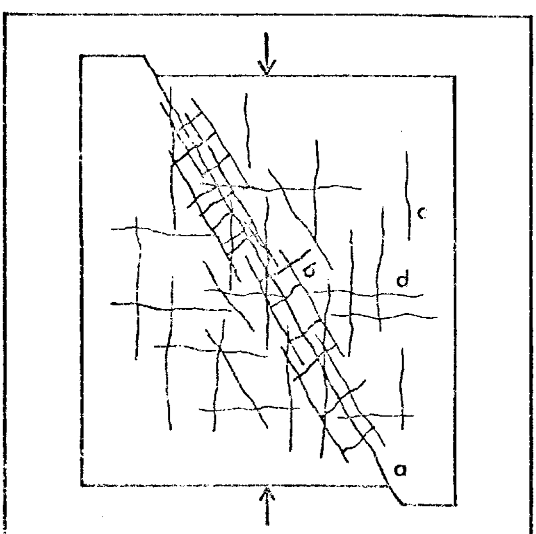

FIG.37

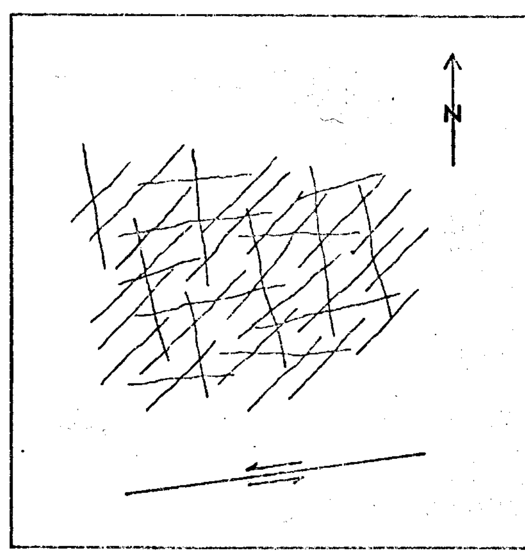

FIG.38

Propylitic Alteration

Propylitic alteration is the weakest and most wide spread type of alteration in the Desert Mountain area. Epidote is common in fractures in the granodiorite. Epidote and calcite were also observed in and near Sec. 16 T. 12 S., R. 7 W.. Other small areas of propylitic alteration were observed.

Pyritic Alteration

Pyritic alteration is characterized by "Limonite" staining which is a byproduct of the oxidation of the pyrite. There are many small areas that have had the introduction of pyrite which usually occurs along fractures. Only the larger areas of pyritic alteration will be noted. As already mentioned the altered, acid volcanic rocks and the sanded-altered volcanic rocks are characteristically altered and pyrite has often been introduced. There is a large area of pyritic alteration controlled by a nearly north-south shear in Sec. 13, T. 12 S., R. 6 W., and to the north across the Jericho-Callao road. There are several fairly large zones in Secs. 21, 22, and 28, T. 12 S., R. 7 W..

Argillic Alteration

Argillic alteration was observed in the altered areas to the north of the Jericho-Callao road. This type of alteration occurred in both the altered granitic rock and the altered volcanic rock. Clay minerals were also observed with the microscope. Argillic alteration was observed in a few other areas.

Silicification

Silicification as noted above is present in the altered, acid volcanic rocks and the sanded-altered volcanic rocks. Silicification is present in the granitic rock immediately to the north of the Jericho-Callao road. Silicification is intense enough to have produced localized jasperoids in the volcanics near and in the two probable cinder cones as mentioned above. There has been silicification in the zone of the thrust faults producing jasperoid in the quartzites and argillites. Many of the blocks in the diatremes are jasperoid also. Sericite was observed in Sec. 15 and 16 T. 12 S., R. 7 W. in the sanded-altered volcanic rock.

GEOCHEMICAL SAMPLE RESULTS

A few geochemical samples were collected and analyzed for the purpose of comparing the different igneous rocks and some of the veins exposed by prospect holes. Samples were also collected from altered and mineralized rocks that had not been probed by prospectors.

The samples were analyzed to determine the presence of metallic elements not normally found in rock forming minerals. The samples were analyzed for Cu, Pb, Zn, Mn, Mo, Ag, and Au on the atomic absorption unit. Some of these samples were qualitatively analyzed on the emmission spectrograph. The results are shown in table 1.

The metal content of some samples is quite high, but they were collected from obviously mineralized areas.

ECONOMIC GEOLOGY

Desert Mountain Mining District

The Desert Mountains and the Allison Knolls make up the Desert Mountain Mining District. There is very little information available on the area. The mineralization has been spotty and the deposits small. These factors together with the remoteness of the area are the reasons for very little production.

Mineralization

The mineralization took place after the dark aphanitic dikes were emplaced. This is known because in the Rockwell Shaft, the dike rock is mineralized. The major structural control seems to be the N. 5° W. shears, joints and faults. The localization of the mineralization is favored by a cross structure and locally the mineralization follows the prominent sheeting. Most of the mineralization is in the western

TABLE I

GEOCHEMICAL SAMPLE RESULTS (See Fig. 39 for Location of Samples)

Sample	Rock Type	Cu	Pb	Zn	Mn	Mo	Ag	Au	Usual Elements Present
#1	Granite	8	22	26	190	1	0.6	0.1	Not run
#2	Granite	3	10	16	170	1	0.7	0.3	Ga, V, Cr, Ni, Co
#3	Granodiorite	4	24	64	540	1	0.9	0.2	Ga, V, Cr, Ni, Co
#4	Volcanics	2	14	14	155	1	0.7	0.2	Not run
#5	Jasperiod in Tc Diatreme	21	34	18	29	3	0.7	0.2	Not run
#6	Dolomite	26	28	10	190	6	1.8	0.6	Not run
#7	Quartzite Jasperoid	17	76	30	16	1	0.6	0.2	Not run
#8	Granite (altered)	6	32	4	35	1	0.7	0.3	Cr, Ga, Ni, V
#9	Shear in altered Volcanics	13	84	14	33	4	30.0	0.5	Cr, Ga, Ni, V
#10	Shear in Diatreme Volcanics	13	126	450	38	1	0.8	0.2	Not run
#11	Quartz Vein	680	2600	310	27	3	2.7	0.3	Not run

TABLE I (cont.)

GEOCHEMICAL SAMPLE RESULTS (See Fig. 39 for Location of Samples)

Sample	Rock Type	Cu	Pb	Zn	Mn	Mo	Ag	Au	Usual Elements Present
#12	Quartz Veins	85	42	76	1220	39	2.3	0.2	Ba, Bi, Cr, Ga, Ti, V
#13	Jasperoid	11	26	14	150	1	0.8	0.2	Cr, V
#14	Vein	13	8	12	19	13	8.0	0.4	Cr, Co, Ga, Ni, Ti, W, V
#15	Quartz Vein	1260	12800	138	300	55	12.0	0.3	Cr, Co, Ga, Ni, Ti, V
#16	Fault Gouge	70	6200	47000	720	80	13.0	0.4	Not run
#17	Fluorite Vein	3100	4200	6500	920	3	56.0	0.8	Ba, Ga, Ni, Sr, V
#18	Hematite Stringers	32	52	20	107	1	0.7	0.2	Cr, Co, Ga, V
#19	Sanded Volcanics	13	12	4	28	14	0.7	0.3	Not run
#20	Copper Vein	17600	50	28	30	59	21.0	0.5	Bi, Cr, Co, Ga, Ni, V
#21	Quartz Vein	2600	415	2600	165	23	34.0	0.4	V
#22	Copper Stained Granite (altered)	3400	66	36	68	2	1.9	0.1	Not run

* Element - values in ppm.

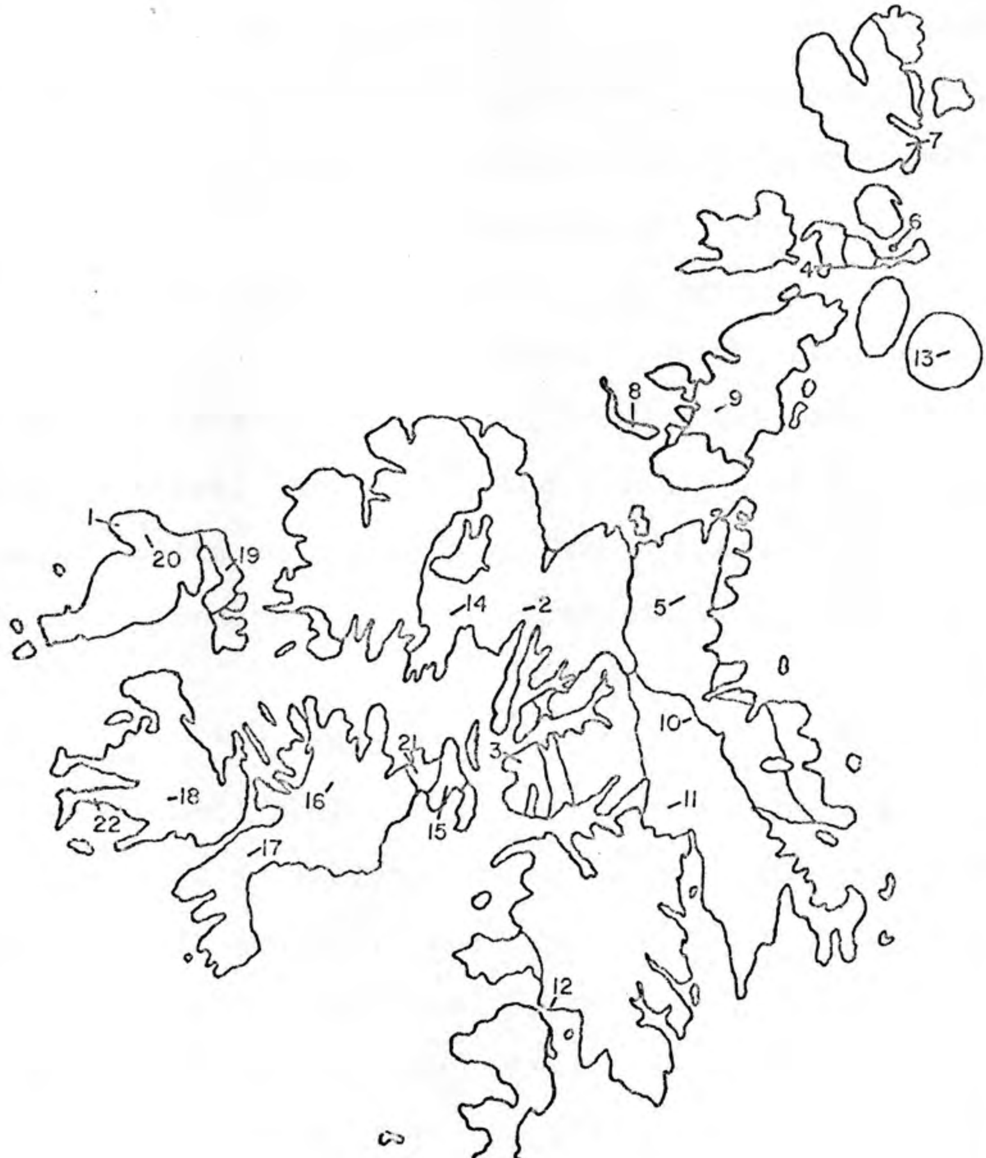

FIGURE 39.

MAP LOCATING GEOCHEMICAL SAMPLE POINTS
See Table I

part of the mountains.

Within the western part of the area are many small hematite stringers, some of which carry visible copper minerals. These stringers generally have an approximate strike of N. 5° W.. In the same locality are some copper veins which have been prospected. The vein minerals are quartz, barite, hematite, magnetite, pyrite, chalcopyrite, bornite, chrysocolla, brochanite (and/or antlerite), manganese oxides, "limonite", and locally some tetrahedrite, galena, fluorite and malachite. There are several prospects which have a moderate amount of fluorite.

Rockwell Shaft

The Rockwell Shaft is located in Sec. 28 T. 12 S., R. 7 W.. It is an inclined winze, dipping 60° west following the vein in granite. The shaft is 325 feet deep and has two levels, the 135-foot and the 325-foot levels. The 135-foot level has over 400 feet of workings, while the 325-foot level has less than 60 feet of drifts. There are two small stopes on the 135-foot level.

The vein strikes N. 10° W.. "The outcrop of copper-stained rock is 6 to 8 feet wide. It is partly covered by dump debris but is exposed for at least 50 feet south of the shaft which begins in ore. The cliffs, however, on the spur just north of the shaft, although they are cut by a strong north-south fissure zone in line with the vein, show no vein material." (Loughlin, in Butler, 1920, p. 444). There is evidence of the vein in the next outcrop to the north. A dark aphanitic dike is in the footwall most of the way down the shaft which has some associated mineralization. The mineralization is more intense where the vein is crossed by a northeast shear and one of these shears offsets the vein. The grade of "ore" is best on the 325-foot level and is approximately 5% Cu, 8 oz. Ag, to as high as .17% U_3O_8 with a little gold and lead present.

The prospect was first located by Oren Porter Rockwell, of early Mormon history, in about 1870 to 1875. The major work took place in about 1905 when as much as 200 tons of ore are reported to have been shipped. Since then the shaft has been maintained and some of the dumps have been hauled away.

The workings were entered with Mr. Howard J. Hassell, the present owner, who supplied me with much of the information above.

Lucky Shepard (?) Mine

The Lucky Shepard (?) Mine is located in the northern part of the Allison Knolls. The mine is apparently a small shaft in the Precambrian quartzites. Mr. Hassell (1970, personal communication) said that he had visited the mine in the 1930's and had seen lead-silver ore in place. After

World War II he revisited the mine and the ore was gone, so there must have been some production from the mine. There are several diggings at this location and they were visited. A very weak structure is exposed in an adit and a little pyrite and vein quartz was found on some of the dumps, nothing to suggest any production or good mineralization. However, during the fall of 1970, a small brick building was being constructed at the prospect.

Other Prospects

There are prospects scattered over much of the area. In Sec. 21, T. 12 S., R. 7 W. along a structure which is a fault or is sheeting and strikes about N. 15° W. there are several prospects. Some of these small prospects apparently located small pods of relatively high grade copper "ore", which is on the dumps now. There is a cluster of prospects in each of Secs. 16 and 23, T. 12 S., R. 7 W..

Economical Potential

The economic potential of the Desert Mountain Mining District, as exposed in outcrop is not good. The Rockwell Shaft, with a local market, may have some potential because ore grade rock occurs in the shaft. The only area with possible favorable alteration is just north of the Jericho-Callao road.

The major east-west structural zone, discussed above, has not only controlled the igneous activity but also mineralization of the region. For this reason the Desert Mountain region would be a favorable location for prospecting in areas under alluvial cover.

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